O F F I C E O F E N E R G Y

Office of *Energy*

GUIDELINES for

Safe Working with Gas in Consumers' Installations

'99 EDITION

FOREWORD

These *Guidelines for Safe Working with Gas in Consumers' Installations* are principally intended to assist persons who are involved in managing, supervising or carrying out gasfitting work.

They should also be useful for training organisations, as well as persons conducting safety awareness talks or presentations to industry personnel.

The *Guidelines* are based on industry standards and codes where practicable and are for informative purposes only. Industry operatives have no statutory obligation to follow them (other than where reference is made to current regulatory requirements).

They were prepared by the Office of Energy of Western Australia.

The Office of Energy hopes that the release of these *Guidelines* will help improve the safety of gas fitters.

They may be used to assist safe working practice awareness, gas fitter training generally and as a reference for safety talks in industry.

This is the first edition and we welcome comments and suggestions from industry, for its improvement.

Any enquiries or comments in relation to the *Guidelines* may be addressed to:

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1 SCOPE AND APPLICATION

These guidelines identify potential hazards and outline recommended principles, procedures and methods of safe work on consumers' gas installations which fall within the scope of Australian Gas Association Installation Code (AG601).

This means the guidelines cover work on:

- pipework generally supplied with gas at pressures not greater than 200KPA downstream of a master meter;
- pressure controls;
- pressure raising devices;
- gas appliances; and
- gas appliance flues and ventilation.

The recommended minimum standards set out in these guidelines may be achieved through application of quality systems, training courses, hazard analyses and installation designs that improve personnel safety when installing or maintaining gas systems.

These guidelines are not intended to apply to work performed on gas distribution systems or LPG storage facilities of capacity greater than 500 litres water capacity for tanks and 1000 litres aggregate water capacity for cylinders.

These guidelines shall be disregarded if found in apparent conflict with any relevant legislation.

2 INTRODUCTION

The work covered in these guidelines is covered by the generic term gasfitting and includes any work involving the installation, removal, demolition, replacement, alteration, maintenance or repair of any gas installation covered by the scope of AG601.

The technical requirements for such installations are detailed in AG601; these guidelines are designed to provide information on recommended safe work processes for working on such installations.

Particular processes which are addressed are:

- pressure testing of gas pipework;
- commissioning and decommissioning of gas pipework;
- purging of gas pipework;
- working on gas pipework and pipework systems;
- testing and commissioning gas appliances and controls;
- conversion of appliances; and
- pressure regulation.

3 REFERENCED DOCUMENTS

The following publications are referred to in this document:

AG601.1998	Australian Gas Association Gas Installation Code
AS3814 AG501.1998	Australian Gas Association Code for Industrial and Commercial Gas Fired Appliances
AS/NZS1596.1997	Storage and Handling of LP Gas
AS/NZS2430	Classification of Hazardous Areas
IEC61508	Functional Safety : Safety Related Systems
IGE/UP/1.1995	Institution of Gas Engineers Communication No. 1583 Soundness Testing and Purging of Industrial and Commercial Gas Installations
Purging Principles and Practice	American Gas Association

4 DEFINITIONS AND ABBREVIATIONS

Definitions and abbreviations will normally be interpreted as shown in a particular standard, code or document unless, in regulations they are, for the purposes of those regulations, stated to have another meaning.

Terms which are used in this document are, for convenience, listed below:

- AGA: Australian Gas Association.
- Appliance/Gas Appliance: An appliance that consumes gas for any purpose.
- Appliance, Type A: An appliance of a class or type specified in Schedule 1 of the Gas Standards (Gasfitting and Consumers' Gas Installations) Regulations 1999.
- Appliance, Type B: An Appliance that has a maximum hourly input rate exceeding 10 megajoules, but is neither a Type A appliance nor a mobile engine.
- Approved: Means approved by the Director of Energy Safety.
- Authority: The Authority having statutory powers delegated under various Acts of Parliament.
- Commissioning: Bringing into operation.
- Field Check List: A check list referred to in Appendix G of AS 3814/AG501, as an aid to the field testing of a Type B gas appliance.

5 AUTHORIZATION OF GAS FITTERS

Gasfitting is a regulated activity. Therefore it can only be performed under a system of licensing.

Licences may :

- be held by an individual (a registered gas fitter)
- authorise the supervision of unlicensed persons carrying out defined gasfitting tasks
- apply to one or more classes of gasfitting, such as:
    - domestic
    - industrial
    - mobile engines
    - vehicle refuelling installations
- be subject to conditions such as:
    - installation only
    - servicing only

The arrangements for the licensing of gas fitters in WA are summarised in Appendix I. More detailed information can be accessed via the Internet on http:\\www.energy.wa.gov.au

5.1 Obligations of Gas Fitters in Relation to Safe Working with Gas

Gas fitters are responsible for safety both in the conduct of gasfitting tasks and in respect of the installations they work on.

The following provides guidance on the obligations and responsibilities of licensed operatives:

- ***Permit Holder Generally***
  A gas fitter must ensure that installations are safe and that all phases of the work they do are managed to ensure safe outcomes.
- ***Permit Holder Supervising a Trainee or a Restricted Permit Holder eg. welder, trainee gas fitter***
  Where the holder of a restricted Permit is able to carry out gasfitting under the supervision on an unrestricted permit holder, that unrestricted permit holder is responsible for the safe conduct of the gasfitting work as well as the regulatory compliance.

This is necessary for all aspects of the work. For example, a welder with a Permit to weld high pressure gas pipework, will need to be directed by the qualified gas fitter as to the safe working methods (ensuring gas free conditions, isolation tagging, safe working areas etc), and that person will subsequently be responsible for the testing and putting the installation into service.

Likewise, a gas fitter delegating tasks to a trainee gas fitter must ensure that the trainee is aware of all safety issues and procedures, and has specific instructions regarding the scope of his/her work, in particular in relation to turning gas on to installations and appliances.

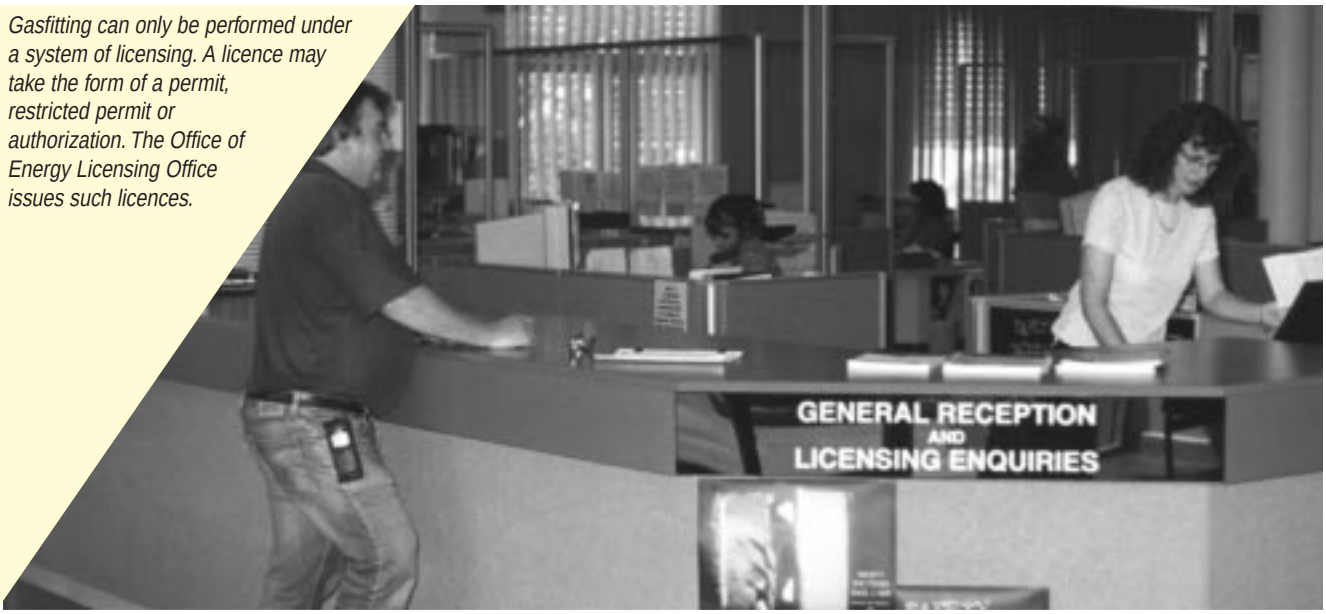
- ***Authorization Holder (Supervising Gas Fitter)***
  A supervising gas fitter will generally be involved with a multi-skilled workforce whose tasks peripherally involve gas, e.g. an electrician wiring gas controls or a mechanical fitter removing/replacing gas-carrying components.

  These supervised gas fitters will be controlled in their gas work through a combination of direct supervision, written procedures and training.

  The supervising gas fitter is responsible for establishing the correct balance and ensuring both the correctness of the work, compliance with the scope of the Authorization and the safety outcomes in relation to the installation and the conduct of the work.

- ***Supervised Gas Fitter***
  A supervised gas fitter, working under the supervision of an Authorization holder, should only carry out gas related tasks which are within the scope of the Authorization and for which training has been received or supervision is direct and based upon specific procedures. There should be some form of supervisory process in place with appropriate “sign offs” and tagging arrangements to ensure safety outcomes are achieved.

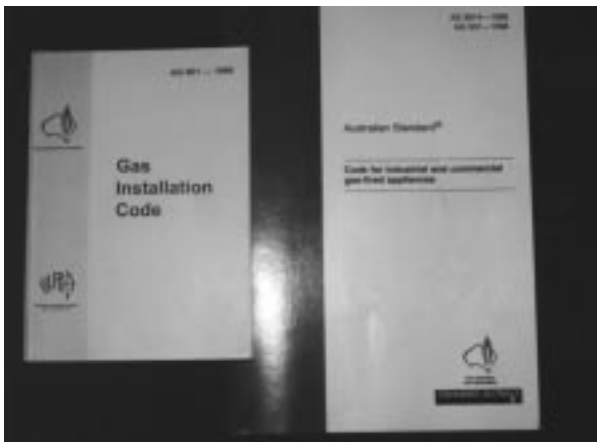
Gasfitting can only be performed under a system of licensing. A licence may take the form of a permit, restricted permit or authorization. The Office of Energy Licensing Office issues such licences.



Industrial gas safety training can be obtained from training providers. Holders of authorizations are responsible for ensuring appropriate training is provided for supervised gas fitters

6 APPROVAL PROCESSES

Various aspects of gas installations are subject to some form of “approval” or scrutiny as follows:



- Design Approval: Generally for large/unique installations and Type B appliances, where the design approval is required prior to installation and is subsequently verified by inspection.

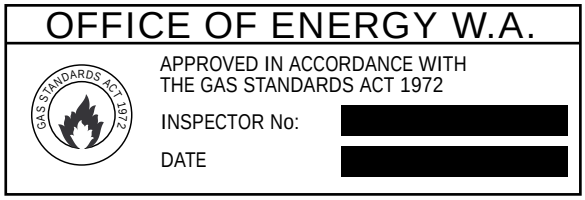
  This process may be determined by the Authority to be by compliance with standards, or by risk analysis, or both.

AS 3814/AG501 is the code for Type B (generally large industrial/commercial gas appliances). AG601 is the code for domestic, commercial, industrial, caravan and marine gas installations.

- Product Certification: Normally of appliances and components by an agency, such as the AGA, or the Authority, and based upon a testing regime.

Typical approval badges for Type A gas appliances

- Product Qualification by Design Compliance: Normally for pipe flanges and fittings, which are manufactured in compliance with a technical standard.
- Certification of Installation Compliance with Prescribed Requirements: Generally of completed installations where compliance must be declared for commencement of supply.
- Inspection by gas undertaker/pipeline licensee:
  Can be either an audit process of sample installations declared compliant by an installer, or a permissive process on a case-by-case basis for large/unique installations.



Gas Standards Act Approval Badge

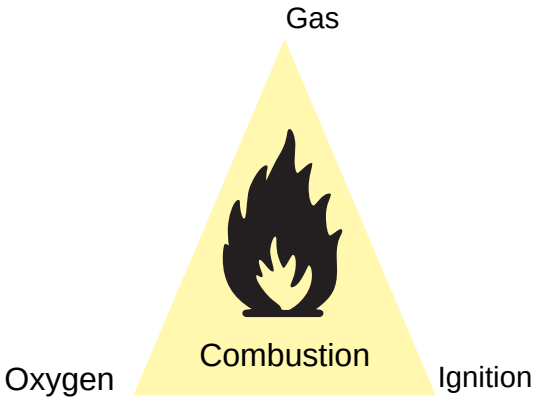
7 GENERAL HAZARDS AND GAS SAFETY INFORMATION

The commonly encountered fuel gases are:

- Natural Gas (NG)
- LPG (mainly Propane)
- LPG (mainly Butane)
- Air/LPG mixtures (TLP, SNG, Towns Gas)

The primary hazard associated with these gases is inadvertent ignition resulting in fire and/or explosion, the prerequisites for which are:

- flammable gas
- oxygen [generally in air]
- ignition source



There is also some risk with most gases, including inert gases used for purging, of asphyxia (suffocation due to exclusion of oxygen) and a risk with fuel gases of poisoning from the products of incomplete combustion, in particular Carbon Monoxide (CO).

Care also needs to be taken in specific situations such as:

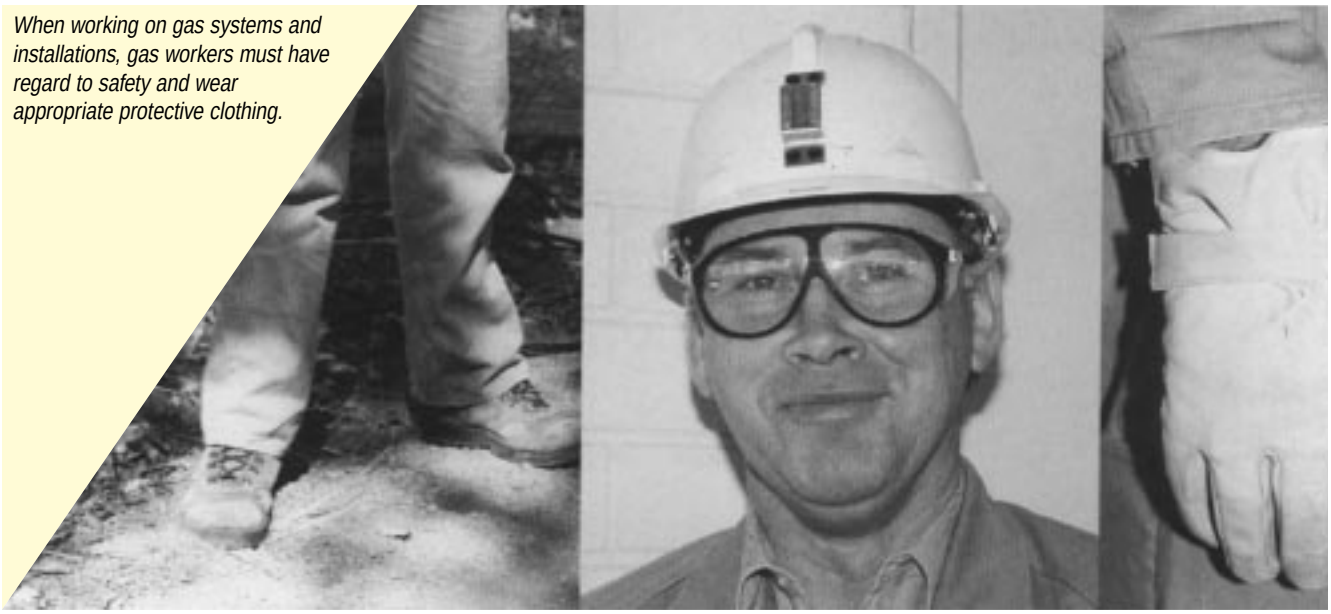
- High pressure installations where stored pressure energy could constitute a danger when fittings/components are disturbed.
- Where static electricity can be generated in pipework.
- Atmospheres are generated, which in themselves are flammable and/or toxic.
- Drying or curing processes which generate flammable and/or toxic fumes.

The following table provides general guidance on safety matters related to Natural and LP Gases and Appendix II gives more detailed information. However, where necessary, specific information should be obtained from the gas supplier.

TYPICAL CHARACTERISTICS OF RETAILED FUEL GASES IN WESTERN AUSTRALIA (1996)

Gas Type	Heating Value	Flammable Limits Gas in Air %		Air for Complete Combustion	Relative Density	Products of Complete Combustion
	MJ/m³	LFL	UFL	m³/m³	Air = 1	
Natural Gas **Methane 87%** **Ethane 5%** **Propane 2%** **Carbon-Dioxide 3%** **Nitrogen 1%** **Plus others**	40	5.0	15.0	10	0.65	**Carbon Dioxide – CO_2** **Water Vapour – H_2O** **Nitrogen – N_2**
Liquefied Petroleum Gas (LPG) **Propane 95%** **Butane 3%** **Plus others**	96	2.5	9.5	24	1.55	**As above**

NOTES:
1. L.F.L. – Low Flammability Level
2. U.F.L. – Upper Flammability Level



When working on gas systems and installations, gas workers must have regard to safety and wear appropriate protective clothing.

8 SAFETY PHILOSOPHY

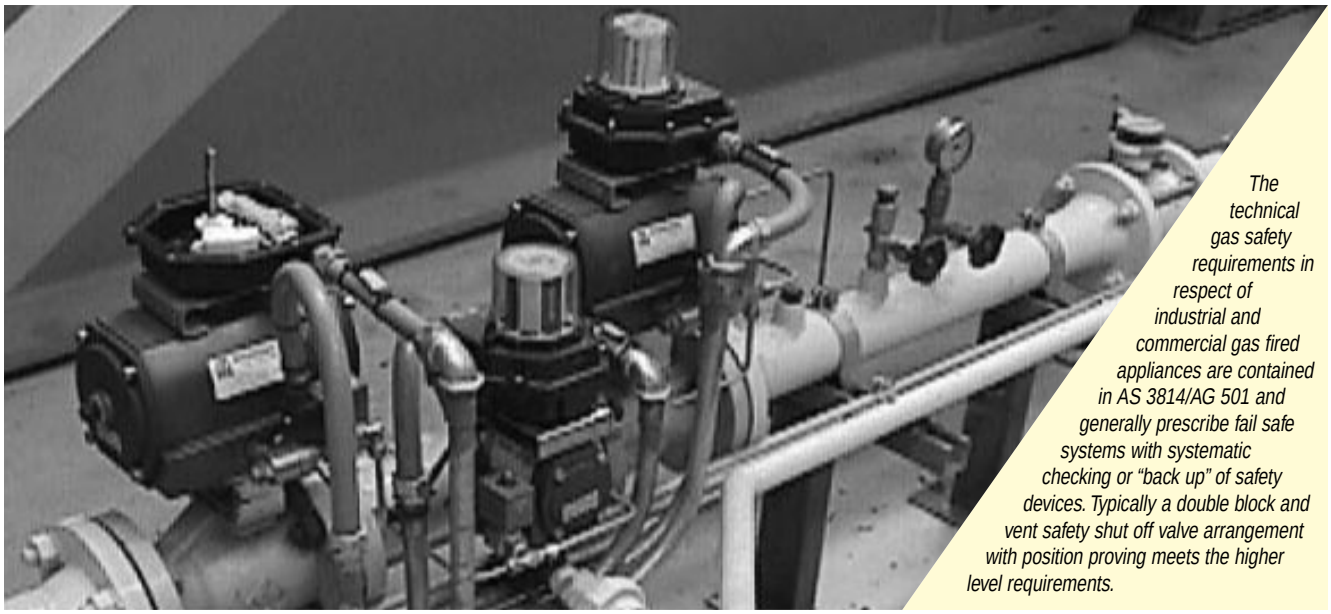
Exclusion or removal of gas from an environment (gas free conditions) is the preferred pre-requisite for working on or in that environment, or for starting a combustion process. This can be achieved in a number of ways, including:

- On pipework downstream of an isolation device which is turned off and tagged, carry out work with:
  - disconnection with a blank or plug installed;
  - insertion of a spade/disc/shim between two fittings;
  - double block valves with a vented interspace, or single valve with a vented body;
  - in controlled conditions with constant forced ventilation providing adequate dilution;
  - with constant internal inert gas purge (with precautions taken to prevent asphyxiation).

Where gas free conditions cannot be guaranteed, for example when the means of isolation is inaccessible or inoperative, additional precautions and procedures will be required such as constant monitoring, breathing apparatus, protective clothing, non sparking tools etc. Such operations should only be considered when adequate safety precautions can be taken and under qualified supervision using approved procedures.

Note: Guidance on purging pipework is contained in AG601 and other documents such as IGE/UP/11994 and American Gas Association publication “Purging Principles and Practice” and the treatment methodology for hazardous areas is contained in AS 2430.

- Where gas is to be introduced into a combustion chamber as part of the commissioning of a combustion process:
  - Double block or double block and vent valves with appropriate safeguards (valve proving, flow control devices, over pressure protection etc);



The technical gas safety requirements in respect of industrial and commercial gas fired appliances are contained in AS 3814/AG 501 and generally prescribe fail safe systems with systematic checking or “back up” of safety devices. Typically a double block and vent safety shut off valve arrangement with position proving meets the higher level requirements.

- Manual isolation to limit gas input (commissioning valve, electrical isolation of safety Shut Off Valves etc);
- Purging the combustion chamber with air or inert gas;
- Controlling the energy release and light-up process.

The requirements in respect of industrial and commercial gas fired appliances are contained in AS 3814/AG 501 and AS 1375.

It is generally accepted that systems which should be designed to ensure that no one failure can cause a hazard (typically, double block valve systems, over pressure shut-offs etc meet this intent).

Programmable Electronic Systems (PES) are not considered to achieve this unless they are further qualified by a certification body and/or subjected to detailed analysis (for example using IEC 61508).

9 WORK PROCESSES

9.1 Purging Principles (Pipework and Components)

For the purposes of these guidelines and in relation to pipework and components, purging is:

- the displacement of air or inert gas by fuel gas;
- the displacement of fuel gas by air or inert gas;
- the displacement of one fuel gas by another fuel gas.

These guidelines deal with purging of all sizes of consumers' gas installations to which AG601 applies.

Purging is required under the following circumstances or generally whenever there is a possibility of air being present in pipes used for conveying gas:

- the installation, maintenance, alteration or removal from service of gas fitting lines;
- the loss of pressure within gasfitting lines;
- the installation, removal or maintenance of gas controls including secondary meters;
- where air or an extraneous gas is suspected of having been introduced into a gas fitting line.

It should be noted that the diversity of gas installations is such that every circumstance cannot be covered in these guidelines.

Attention is therefore drawn to the requirement for personnel of adequate experience and responsibility to carry out purging operations, based on safety principles such as set out in these guidelines.

BASIC REQUIREMENTS

- A soundness (leakage) test shall be conducted immediately prior to any purge admitting fuel gas (or inert gas if this is to be immediately followed by fuel gas).
- Purging should not be commenced without a full knowledge of the gasfitting line system; it is the responsibility of the person in charge to check the accuracy of any plans, information etc.
- In all but the most simple purge operations, a written procedure, appropriate to the installation and type of gas, should be prepared and followed.
- All sources of ignition shall be excluded from areas where gas may become present during a purge.
- Processes and procedures (such as tagging and permits to work) should be in place and followed before, during and after purging.
- Care should be taken to avoid confusion between oxygen cylinders and inert gas cylinders.
- Vent points shall be carefully selected to avoid build up of fuel and inert gases leading to risks of explosion or asphyxiation. If necessary positive precautions shall be taken to prevent asphyxiation.
- The relative density of purge gases (fuel and inert) shall be considered when venting, sampling and/or testing eg. CO_2 and LPG are heavier than air, Natural Gas is lighter than air.
- When conducting a purge using air or inert gas under pressure, precautions shall be taken to prevent reverse flow into the fuel gas supply system.
- A purge should never be left incomplete.
- Where gasfitting line is purged through an appliance burner, no ignition source shall be applied until any build up of fuel gas has dissipated.

When purging large or complex systems, it is essential to use a reliable and accurate means of checking gas concentrations.

Guidance on purging is contained in a number of industry publications including AG 601, Institution of Gas Engineers Communication No 1583, IGE/UP/1.1995 and American Gas Association publication Purging Principles and Practice.

9.2 De-Commissioning Pipework

Where work is to be carried out on gas-carrying components (pipework, controls, valves), it may be necessary to do one or more of the following:

- isolate the supply by turning off a valve or valves;
- apply isolation tags;
- de-pressurise the section of pipe or control train which is to be worked on;
- remove the gas in the pipework via a safe discharge point;
- replace the gas with an inert gas (N_2 or CO_2) or air;
- provide an indication of work in progress and prohibit/prevent operation of isolating devices;
- monitor the contents of pipework and surrounding atmosphere at intervals or continuously.

Decisions regarding the precise actions to be taken must be made after careful consideration of all factors.

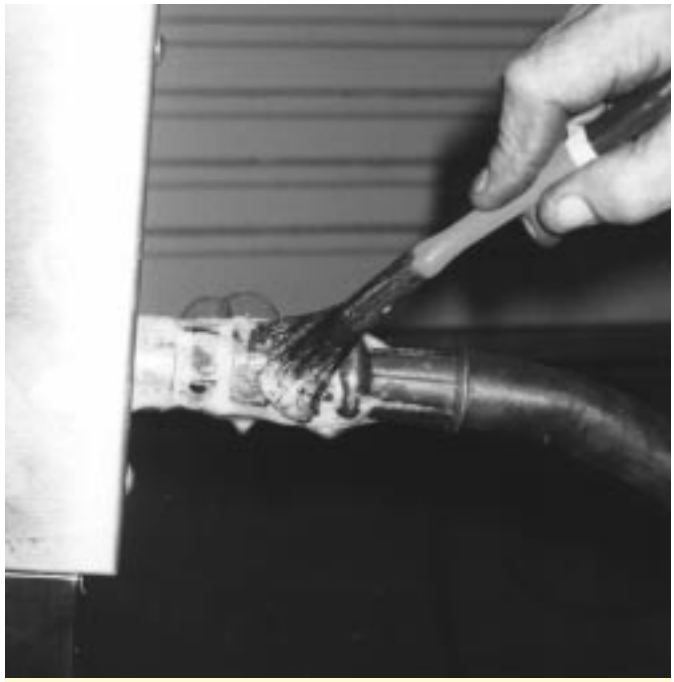
Points to be considered should include:

- size (diameter and length) of the installation being de-commissioned;
- the method of verifying any purge is complete (gas analyses etc);
- the pressure of the gas supply;
- the need for an inert gas purge;
- duration of the shut down;
- the risks associated with venting of gas or the purging medium;
- the complexity of the installation;
- the potential for igniting gas (welding, power tools etc);
- the level of natural or forced ventilation;
- the type of gas (heavier or lighter than air);
- the environment surrounding the installation;
- erecting warning signs and/or barriers.

9.3 Commissioning Pipework

Commissioning of (introduction of gas into) pipework must always be subject to pipework being qualified (by testing) for the pressure to which it will be subjected. It must always be immediately preceded by a soundness (leak) test; however, decisions regarding the specific additional processes necessary must be made after careful consideration of all factors, such as:

- checking of pressure/strength test records;
- size (diameter and length) of the installation;
- the pressure of the gas supply;
- the need for an inert gas purge;
- the method of verifying any purge is complete (gas analyses etc);
- the risks associated with venting of gas or purging medium;
- the type of gas (heavier or lighter than air);
- the location of purge gas vents;
- the complexity of the installation;
- the rate at which gas is introduced (to prevent shock loading of components or overspeed of meters);
- the pressure (and therefore velocity) of the gas/purging medium being introduced;
- erecting warning signs and/or barriers.



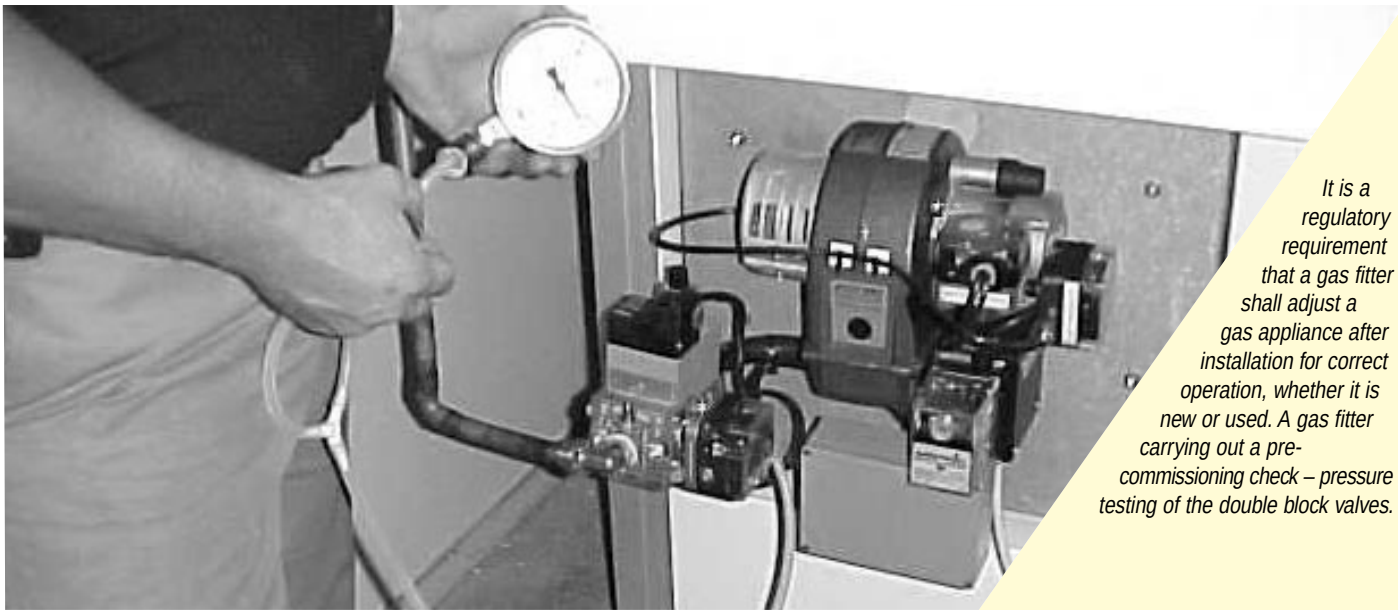
Checking for gas leaks on the gas pipework system is a must prior to bringing appliances into operation.

9.4 Commissioning Appliances

Appliances require to be commissioned (brought into operation).

It is a regulatory requirement that a gas fitter shall adjust a gas appliance after installation for correct operation, whether it is new or used, and demonstrate to the user the correct method of operation. For Type A appliances, the manufacturer's commissioning instructions should be followed. Guidance on commissioning of Type B gas appliances is contained in AS 3814/AG 501. However, whether commissioning is in accordance with manufacturer's instructions, or follows a procedure produced specifically for a particular item of plant or circumstance, there are a number of overriding safety issues which must be considered including:

- correctness of installation and siting taking account of contaminants and hazards in the vicinity e.g. dust, chemicals etc;
- all necessary services, exhausts, ventilation (including combustion air) etc. must be in place and the air supply adequate taking account of entry and termination points;
- operation of the appliance throughout its range must not create a hazard;
- all emergency and limit controls must be in place and checked for effective operation and not be capable of being readily disabled;
- gas carrying components must be checked for leaks;
- air flow for purging and combustion must be adequate and unrestricted, e.g. dampers must be set to an adequately open position;
- gas pressure settings must be set at safe levels;
- where necessary or mandatory, gas supply to burners must be capable of being isolated;
- exhaust outlet and vent lines must be terminated correctly;
- adequate instruments must be available, within the appropriate accuracy limits and where necessary connected correctly;



It is a regulatory requirement that a gas fitter shall adjust a gas appliance after installation for correct operation, whether it is new or used. A gas fitter carrying out a pre-commissioning check – pressure testing of the double block valves.

- emergency exits must be clearly identified and open;
- explosion reliefs where necessary must be installed and operable;
- where necessary, written procedures must be produced;
- all personnel involved must be competent and adequately briefed;
- all persons who may be affected by the commissioning must be briefed and instructed as to their safety;
- any necessary warning notices must be in place;
- supply safeguards must be in place and effective;
- gas supply pipework and components up to the burner must be purged to gas and any gas released during purging must be adequately dispersed.

The complexity of this process and the extent to which specialist knowledge and equipment is required will depend upon the nature of the appliance and its purpose. Generally the designer's/manufacturer's instructions should be followed where these are available.

Where a Type B appliance has been approved for installation, and may therefore be commissioned, the commissioning gas fitter must ensure and record that the various safety features are operative/effective.

AS 3814/AG501 contains as Appendix G a *Field Check List.* This suggests an appropriate format to be used during and after commissioning and prior to inspection. It includes typical (but not totally comprehensive) performance checks.

This *Field Check List* must be produced to the inspector before he carries out his final inspection and may be used as the basis for the inspection.

9.5 Conversion of Appliances

Both Type A and Type B appliances may be converted from another fuel (eg. coal or oil) to gas. These will generally be treated as new appliances and require full approval.

Conversions from one gas to another (Natural Gas to LPG and vice versa) also require approval, but these can be more straightforward, particularly for Type A appliances designed for use on both gases (generally requiring a manufacturer's conversion kit).

However, some Type A appliances and most Type B appliances require conversion based upon a design which takes account of the specific requirements of the appliance and installation.

This should only be considered by competent, trained persons with specialised knowledge and, in some cases, access to accredited test facilities. Such conversions should only be done with the knowledge, cooperation and approval of the (new) gas supplier's inspector or, in the case of a Type B appliance, an accredited inspector.

Important safety considerations include:

- Natural gas and LPG have different characteristics, in particular heating values, therefore all gas inputs must be recalculated and throughput controls adjusted, modified or replaced.

- The safety regime of an appliance must be brought up to current standards, for example:
    - where required, oxygen depletion detectors must be fitted,
    - on Type B appliances, replace double block and vent systems with valve proving or leakage detection when converting to LPG,
    - old controls may not be up to standard.
- Start gas rates/pilots need to be reassessed and adjusted.
- The safety implications of going to or from heavier or lighter than air gas must be taken account of, particularly during purging and commissioning.
- When going from a rich gas (LPG) to a comparatively lean gas (Natural Gas), supply and burner head pressures need to be calculated and possibly modified to take account of pipework and component sizing.

These are just some of the considerations.

Conversions should not be approached lightly, and only be undertaken when the necessary approvals have been obtained and, even then, normally only after consulting the original designer/manufacturer or an expert in the field.

9.6 Gas Pressure Regulation

Generally, gas is only used with some form of pressure regulation; ie. gas supply pressure is controlled to a pre-set level, both for safety and to ensure correct combustion. Pressure regulators are normally installed:

- at the inlet to a consumer's installation (meter, cylinder or tank) to control and limit the pressure in the installation;
- before burners or appliances to control and limit the pressure into the control system (gas train);

Gas supply pressure is controlled to a pre-set level, both for safety and to ensure correct combustion. Pressure regulators with over-pressure protection are normally installed before burners or appliances to control and limit the pressure into the gas train system.

- where a specific reduction in pressure is required within a consumer's installation.

AG601 and AS 3814/AG501 both specify the requirements for gas pressure regulation in specific situations, including where over or under pressure protection needs to be provided.

No work should be undertaken on a gas installation without a thorough knowledge of the gas pressures in the system.

There are requirements for identification of pipework in AG601, including marking of the gas pressure where it exceeds 7kPa. However, some installations may not be marked; therefore caution is advised, particularly on non-domestic installations.

Adjustment of regulators should only be carried out:

- by competent persons with the full knowledge and permission of the owner;
- with a comprehensive knowledge of all equipment downstream of a regulator;
- within the pressure holding capabilities of downstream pipework, and within the range for which an appliance or downstream component is approved;
- only with an inspector's approval, where it constitutes a modification to an appliance (by increasing its consumption);
- when the downstream pressure can be monitored directly by the person adjusting the pressure;
- when, if required for a newly approved pressure, any necessary safety devices are installed and effective;
- in compliance with any relevant code or standard, in particular AG601 and AS 3814/AG501.

9.7 Permits to Work and Tagging

Whenever a system is being worked on, there should be no doubt regarding the systems status.

Tagging of pipework when appliance is defective and cannot be operated.

Therefore, there should be procedures in place for tagging isolation points to ensure that they are not wrongly operated, and for complex installations/operations, a Permit to Work system should be put in place.

For example:

- All valves either to or from a section being worked on, tested or purged should be clearly labelled (tagged) e.g. “Do Not Open – Purging/Testing/ Welding In Progress”.
- Work should be prohibited on a pipework section undergoing purging.
- Permit to Work systems should be employed, particularly where appliance commissioning, cutting, welding or opening up of any pipework or associated equipment is to be carried out.

APPENDIX I
ARRANGEMENTS FOR LICENSING GAS FITTERS IN WA

The *Gas Standards (Gasfitting and Consumers' Gas Installations) Regulations 1999* detail the licensing requirements for gasfitting work in Western Australia.

This document explains how those licensing requirements apply to gas fitters,

This document is not intended to be a complete statement of Office of Energy policy, nor does it attempt to waive or modify any legal obligation.

Enquiries: Please contact the Office of Energy Licensing Office at:

Technical & Safety Division
20 Southport Street
West Leederville WA 6007

Telephone: 08 9422 5282
Facsimile: 08 9422 5222
Website: www.energy.wa.gov.au
Email: safety@energy.wa.gov.au

Licensing of Gas Fitters

In Western Australia, the *Gas Standards Act 1972* provides that gasfitting work on gas installations and gas appliances may only be carried out by a person with the appropriate gas fitter's licence. A licence may take the form of a permit, restricted permit or authorization.

Gasfitting Work

Any operation, work or process in connection with the installation, removal, demolition, replacement, alteration, maintenance or repair of a gas installation in or on any land, premises, caravan, marine craft, or other thing (the installation or conversion of an engine is included), shall be taken as gasfitting.

It is illegal for a person to do any gasfitting work on a consumer's installation, where the *Gas Standards (Gasfitting and Consumers' Gas Installations) Regulations 1999* apply, unless the person holds a current Western Australian licence or is working under an appropriate current Western Australian authorization.

Classes of Gasfitting

Gasfitting is categorised into the following classes:

Class	***Description***
Glass G	All gasfitting work except gasfitting work classed as Class I, E or P.
Class I	Gasfitting work – (a) on a consumer's gas installation associated with a Type B appliance; or (b) on piping that has an operating pressure of more than 200 kPa, not being gasfitting work referred to in paragraph (a) or classified as Class E or P.
Class E	Gasfitting work associated with a mobile engine.
Class P	Gasfitting work on a gas installation associated with the storage and dispensing of gas for the refuelling of a motor vehicle as defined in section 5 of the *Road Traffic Act 1974.*

APPENDIX II
GAS SAFETY AND HEALTH HAZARD INFORMATION

NATURAL GAS (NG)

Identification U.N. Number 1971

Product Name:	Natural Gas.
Dangerous Goods Class:	2.1 Flammable Gas
Hazchem Code:	2[S]E
Poisons Schedule Number:	None Allocated
Use:	Normally used as fuel gas or feedstock.
Physical Properties (Typical):	Colourless flammable gas and when odorised it has a disagreeable odour.
Specific Gravity:	0.6 to 0.7 relative to air
Flammability limits:	4% to 17% by volume in air at ambient temperature and atmospheric pressure
Auto-ignition Temperature:	Above 400°C at atmospheric pressure.
Boiling Point:	- 162°C at atmospheric pressure.
Gross Calorific Value:	34-45 megajoules per standard cubic metre (MJ/m^3). 46-54 megajoules per kilogram (MJ/kg).
Net Calorific Value:	31-41 megajoules per standard cubic metre (MJ/m^3). 41-49 megajoules per kilogram (MJ/kg).
In its natural form:	Is colourless and odourless.
Generally supplied:	As an odorised gas by piped transmission or distribution system, or in compressed form in a pressure container (normally for automotive use). A strong and distinctive odorant is added to assist in the early detection of even minor leaks.
Odorant:	Thiophane / Terliary Butyl Mercaptan / Isopropyl Mercaptan
Note:	Non – odorised gas may be use in some industrial applications; check with the gas supplier.
Ratio of expansion Liquid Volume to Gas Volume	1:580

Typical Composition and Combustion Products

Natural Gas – Typical Composition Variation (% by Volume)

Nitrogen	(N_2)	0 – 6
Carbon Dioxide	(CO_2)	0 – 5
Methane	(CH_4)	75 – 95
Ethane	(C_2H_6)	0 – 10
Propane	(C_3H_8)	0 – 5
Butanes	(C_4H_{10}'s)	0 – 2
Pentanes	(C_5H_{12}'s)	0 – 0.5
Hexanes	(C_6H_{14}'s)	0 – 0.3
Higher Hydrocarbons		0 – 0.2

Typical Products of Stoichiometric Combustion

	Wet % by Volume	Dry % by Volume
Carbon Dioxide (CO_2)	10	12
Nitrogen (N_2)	71	88
Water (H_2O)	19	–

Health Hazard Effects

Health Effects

Inhaled:	May cause light-headedness, dizziness and drowsiness.
Acute Exposure:	Excessive exposure may cause unconsciousness or even death, due to asphyxiation.
Chronic Exposure:	No chronic systemic effects reported from industrial exposures, but such exposure should be avoided..

First Aid		First aid should be appropriate to the subject's condition and should be in accordance with recommended procedures.
	Inhaled:	Remove patient to fresh air and allow to rest. If patient is unconscious and breathing, place them in the coma position, check airway and observe. If patient is not breathing, clear their airway and apply mouth-to-mouth resuscitation. If they are not breathing and do not have a pulse, commence cardio pulmonary resuscitation. Seek urgent medical attention.

Important Information

Carbon monoxide is a poisonous gas and can be formed when natural gas is not completely burnt. Therefore it is important that only approved appliances are used, correctly installed and are well maintained. For your own safety always use an authorized gas installers or service agents.

Precautions for Handling and Use (Consumers installations)

Exposure Standards:	No values assigned.
Engineering Controls:	
Supply:	Natural Gas is generally piped to and distributed around a site through specifically designed and tested pipework systems which should be identified as such (eg. by use of marker tape, colour coding, labelling etc). The pressure of the gas within the pipework should be marked on above ground pipes where it exceeds 7 kPa.
Note:	*There may be instances where Natural Gas pipework is not correctly identified or marked.* The pipework system will include isolating valves and pressure reducing devices to isolate and control the gas supply to its point(s) of use. Compressed Natural Gas (CNG), normally used as an alternative fuel for vehicles, will be supplied from onboard cylinders filled to a pressure of approximately 25 MPa.
Fire/Explosion Hazards:	Any incident involving an uncontrolled escape of gas requires immediate remedial action including, dependent upon the location and severity: 1) Evacuate the immediate area. 2) Assessment of the risks. 3) Eliminate all ignition sources. 4) Isolation of the associated pipework upstream of the gas escape. 5) Ventilation of spaces affected by the gas escape. 6) Contact with Gas Supplier, Fire Brigade and other Emergency Services as appropriate. Repairs and recommissioning should be carried out only by authorised persons with due regard to the Gas Standards Act 1972 as amended.
Ignition Sources:	Follow procedures to avoid static discharges. Use non-spark generating tools and flameproof (intrinsically safe) equipment.
Ventilation:	Maintain ventilation. Gas appliances can be hazardous when used in a poorly ventilated room.
Personal Protection:	Should be in compliance with WorkSafe requirements for the task being carried out.
Flammability:	Flammable. Isolate from sources of heat, naked flames or sparks.
Smell:	People with poor or no sense of smell should be made aware of the risk in the event of a gas leak.

LIQUEFIED PETROLEUM GAS (LPG)

Identification U.N. Number 1075

Product Name:	Liquefied Petroleum Gas.	
Dangerous Goods Class:	2.1 Flammable Gas	
Hazchem Code:	2WE	
Poisons Schedule Number:	None Allocated.	
Use:	Normally used as fuel gas.	
Physical Properties (Typical):	Colourless flammable gas and when odorised it has a disagreeable odour.	
Specific Gravity:	Liquid 0.51 to 0.58 (relative to water = 1). Vapour 1.52 to 2.01 (relative to air = 1).	
Flammability Limits:	1.5% to 9.6% by volume in air at ambient temperature and atmospheric pressure.	
Autoignition Temperature:	above 300°C at atmospheric pressure.	
Boiling Point of Liquid:	- 42°C to 0°C	
Vapour Pressure at 40°C:	300 to 1400kPa	
Gross Calorific Value:	90 – 120 megajoules per standard cubic metre (MJ/m^3). 50 – 52 megajoules per kilogram (MJ/kg).	
Net Calorific Value:	85 – 112 megajoules per standard cubic metre (MJ/m^3). 45 – 47 megajoules per kilogram (MJ/kg).	
In its natural form:	Is colourless and odourless.	
Generally supplied:	As an odorised gas in cylinders, tanks or piped distribution system. A strong and distinctive odorant is added to assist in the early detection of even minor leaks.	
Odorant:	Ethyl Mercaptan	
Ratio of expansion Liquid Volume to Gas Volume:	Propane 1:273 (C_3H_8)	Butane 1:238 (C_4H_{10})

Typical Composition and Combustion Products

Analysis

Typical Composition Variation (% by Volume)

		Propane	Butane
Propane, Propene	C_3H_8,C_3H_6	95	10
Butanes, Butenes,		3 – 4	90
Pentanes		<1	<1
Ethane	(C_2H_6)	0 – 2	

Typical Products of Stoichiometric Combustion

	Wet % by Volume	Dry % by Volume
Carbon Dioxide (CO_2)	12	14
Nitrogen (N_2)	73	86
Water (H_2O)	15	

Health Hazard Information

Health Effects

Inhaled:	May cause light-headedness, dizziness and drowsiness
Acute Exposure:	Excessive exposure may cause unconsciousness or even death, due to asphyxiation
Swallowed:	Due to high volatility of product, this is not likely to occur.
Eyes:	Liquid will cause severe damage. Vapour will cause irritation.
Skin:	Vapour will cause irritation. Liquid contact can cause freezing of tissue, resulting in an injury similar to a thermal burn.
Chronic Exposure:	No chronic systemic effects reported from industrial exposures.

First Aid:		First aid should be appropriate to the subject's condition and should be in accordance with recommended procedures.
	Inhaled:	Remove patient to fresh air and allow to rest. If patient is unconscious and breathing, place them in the coma position, check airway and observe. If patient is not breathing, clear their airway and apply mouth-to-mouth resuscitation. If they are not breathing and do not have a pulse, commence cardio pulmonary resuscitation. Seek urgent medical attention.
	Swallowed:	Due to high volatility of product, this is not likely to occur.
	Eyes:	Hold eyes open and continuously wash with clean water while seeking urgent medical attention. Eyewash bottles containing sterile water or normal saline solution should be kept readily available.
	Skin:	Immediately wash affected areas with plenty of water at room temperature to overcome frostbite. Do not use iced water. Warm up gently. In hot conditions, cover with damp sheet to prevent too rapid heating up of affected area. Seek urgent medical attention.

Important Information

Carbon monoxide is a poisonous gas and can be formed when LP Gas is not completely burnt. Therefore it is important that only approved appliances are used, correctly installed and well maintained. For your own safety always use an authorized gas installers or service agents.

Precautions for Handling and Use (Consumers' installations)

Exposure Standards:	1000ppm for LPG (documented by WorkSafe Australia)
Engineering Controls:	
Supply:	May be by cylinder, tank (bulk storage), reticulated supply system or a combination.
Ignition Sources:	Follow procedures to avoid static discharges. Use non-spark generating tools and flameproof (intrinsically safe) equipment.
Ventilation:	Maintain ventilation. LP Gas appliances can be hazardous when used in a poorly ventilated room.
Personal Protection:	Should be in compliance with WorkSafe requirements for the task being carried out. Approved thermally insulated gloves and safety glasses are recommended when handling liquid.
Flammability:	Flammable. Isolate from sources of heat, naked flames or sparks.
Smell:	People with poor or no sense of smell should be made aware of the risk in the event of a gas leak.

Safe Handling Information for LPG Containers

Storage and Transport:	Store in approved areas as defined by current issue of AS1596. Comply with the current issue of the Australian Code for the Transportation of Dangerous Goods by Road and Rail, and with the relevant Dangerous Goods Legislation in each State or territory. Store containers in an upright position (even when empty); keep away from heat sources; do not drop; keep valves closed when not in use. Ensure dust and rain caps are fitted at all times. Store away from oxidising substances eg. pool chlorine. Cylinders must be secured in an upright position for transport.
Spills and Disposal:	Move people away and upwind from spill. Shut off supply of gas if it is safe to do so. Eliminate sources of ignition e.g. power supply. Ventilate area. Remove leaking cylinder to open air. Avoid breathing vapour and contact with liquid or vapour. Disperse vapour with water spray. Note that vapour is heavier than air and will settle at the lowest point e.g. ditches, drains and water courses.
Fire/Explosion Hazard:	Evacuate area, remove ignition sources. Cut off gas supply if safe to do so – do not endanger life. DO NOT EXTINGUISH FIRE – allow gas to burn out. Use water to keep the vessel cool.
Note:	If ignition has occurred and water is not available, the tank metal may weaken from the heat and may result in an explosion. The area should be evacuated immediately. From a safe location, notify emergency services. Combustion Products – Carbon dioxide, water vapour, traces of carbon monoxide and nitrogen oxides. Fumes, smoke, carbon monoxide and aldehydes can be formed during incomplete combustion. Fire fighters may need self contained breathing apparatus.
Other information:	‘EMPTY’ container warning: ‘Empty’ containers retain residue (liquid and/or vapour) and can be dangerous. DO NOT PRESSURISE, CUT, WELD, BRAZE, SOLDER, DRILL, GRIND OR EXPOSE SUCH CONTAINERS TO HEAT, FLAME, SPARKS AND OTHER SOURCES OF IGNITION. THEY MAY EXPLODE AND CAUSE INJURY OR DEATH. Do not attempt to clean since residue is difficult to remove. All containers should be returned to the supplier. Privately owned containers no longer required, should be disposed of in an environmentally safe manner, and in accordance with Government regulations.

General Information

Exposure to Ignited Mixtures of: **Natural and Air.**
LPG and Air.

1) External burns and physical injury due to fire or explosion.

2) Internal burns due to inhaling a flammable air/gas mixture.

3) Carbon monoxide poisoning due to inhaling the products of incomplete combustion.

4) Asphyxia due to inhaling the products of combustion in high concentrations.

5) Eye and nose irritation due to contact with the products of incomplete combustion.

Exposure to Unignited: **Natural Gas.**
LPG (vapour).

Can result in:

1) Asphyxia due to inhaling high concentration gas.

2) Headache, dizziness or similar symptoms due to inhaling moderate concentrations of gas.

3) There is no evidence from available data that external exposure to Natural Gas, as normally distributed, has any adverse health effects. However, such exposure should be minimised.

4) External exposure: see Health Hazard Information.

Pressure: As with any pressurised medium, removal of fittings or components under pressure can result in physical damage or injury.

Note: *Concentrations of gas high enough to induce physiological effects present an extreme fire and explosion hazard.*

In general, no attempt should be made to approach casualties before the gas source has been isolated and the area adequately ventilated. In certain circumstances, an adequately trained and equipped team may effect a rescue from within a hazardous area provided care is exercised to avoid the presence or creation of ignition sources.

Appliances:

Only gas appliances identified as approved should be used.

Identification of approval may be by badge or label in the case of "Type A" domestic, commercial cookers, water heaters and space heater etc.

In the case of "Type B" industrial, commercial (boilers, bakers ovens etc.) and specialised appliances such as hobby pottery kilns, they will need to be individually inspected and approved by an inspector or type approved by the regulatory authority.

Appliances which cannot be identified as being approved may not meet the appropriate safety standard and may be potentially dangerous.

For information contact the appliance supplier, gas supplier or the regulatory authority.

NOTICE

The information given in this publication is intended for general guidance only quantities expressed are typical for the named gases. Specific information should be obtained from the gas supplier.

APPENDIX III
CONVERSION OF UNITS

(Reprinted from Natural Gas Reference Book. Published by the Gas and Fuel Corporation of Victoria -1992).

THE INTERNATIONAL SYSTEM OF UNITS – CONVERSION FACTORS

This system includes the base units of SI, supplementary SI units, derived SI units and the decimal multiples and sub-multiples of these units, formed by use of prefixes. The name 'SI units' is reserved for the coherent units only. (A system of units is coherent if the product or quotient of any two unit quantities in the system is the unit of the resultant quantity.)

SI is based on the following six base or primary units:

Quantity	Unit	Symbol
Length	metre	m
Mass	kilogram	
Time	second	
Electric current	ampere	A
Temperature	*kelvin	K
Luminous intensity	candela	cd

*Common usage of degree Celsius remains.

The expressions for the derived SI units are stated in terms of base units, thus for example the SI unit for velocity is metre per second (m/s).

For some of the derived SI units, special names and symbols exist. The following supplementary and derived units are employed in the system:

Quantity	Name of SI unit	Symbol	Expressed in terms of SI base units of derived units
frequency	hertz	Hz	1 Hz = 1 cycle/s or 1/s
force	newton	N	1 N = 1kg/m/s^2
energy, work, quantity of heat	joule	J	1 J = 1Nm
power	watt	W	1 W = 1J/s
electric charge	coulomb	C	1 C = 1As
electric potential difference, E.M.F.	volt	V	1 V = 1W/A
electrical resistance	ohm	Ω	1 Ω = 1V/A

Quantity	Name of SI unit	Symbol	Expressed in terms of SI base units of derived units
density	kilogram per cubic metre	-	kg/m^3
temperature interval	kelvin, degree Celsius	K.°C	
pressure, stress	pascal	Pa	1 Pa = $1N/m^2$

Additional supplementary and derived SI units relating to space and time, heat, mechanics, electricity and magnetism, and to physical chemistry and molecular physics, have been approved by the International General Conference on Weights and Measures.

Decimal multiples and sub-multiples of the SI units are formed by means of the prefixes given below:

Factor by which the unit is multiplied	Prefix	Symbol
10^{15}	peta	P
10^{12}	tera	T
10^{9}	giga	G
10^{6}	mega	M
10^{3}	kilo	k
10^{2}	hecto	h
10	deka	da
10^{-1}	deci	d
10^{-2}	centi	c
10^{-3}	milli	m
10^{-6}	micro	µ
10^{-9}	nano	n
10^{-12}	pico	p
10^{-15}	femto	f
10^{-18}	atto	a

The symbol of a prefix is considered to be combined with the unit symbol to which it is directly attached, forming with it a new unit symbol which can be raised to a positive or negative power and which can be combined with other unit symbols to form symbols for compound units.

Examples:

$1cm^3$	=	$(10^{-2}m)^3$	=	$10^{-6}m^3$
$1\mu^{-1}$	=			10^6s^{-1}
$1mm^2/s$	=	$(10^{-3}m)^2/s$	=	$10^{-6}m^2/s$

Compound prefixes must not be used, for example write nm (nanometre) instead of mμm. When expressing a quantity by a numerical value and a certain unit, it has been found suitable in most applications to use units resulting in numerical values between 0.1 and 1000.

The units which are decimal multiples and sub-multiple of the SI units should, therefore, be chosen to provide values in this range, for example:

Observed or calculated value	Can be expressed as
12 000 N	12 kN
0.00394 m	3.94 mm
14 010 Pa	14.01 kPa
0.003 s	3 ms

Conversion – British to SI units:

The conversion factors given below relate to those units most commonly used in combustion technology.

Length

1 in.	=	25.4 mm
1 ft.	=	0.3048 m
1 yd.	=	0.9144 m

Area

1 in^2 (square inch)	=	6.4516 cm^2
1 ft^2 (square foot)	=	0.092903 m^2
1 yd^2 (square yard)	=	0.836127 m^2

Capacity

1 gal (gallon)	=	4.54609 dm^3
	=	4.54609 litres

Power

1 hp (horsepower)	=	0.746kW (or J/s)

Volume

1 in^3 (cubic inch)	=	16.3871 cm^3
1 ft^3 (cubic foot)	=	28.3168 dm^3
1 yd^3 (cubic yard)	=	0.764555 m^3

Mass

1 oz (ounce)	=	28.3495 g
1 lb (pound)	=	0.453592 kg
1 cwt (hundred weight)	=	50.8023 kg
1 ton	=	1016.05 kg

Volume – cubic metre (m^3), 1 ft^3 = 0.028m^3 approx. The cubic metre and sub-multiples thereof will be the main units. The litre now defined as exactly equal to the cubic decimetre is retained, also the hectolitre and millilitre.

Volume Flow – cubic metre per second (m^3/s) 1 ft^3/s = 0.028 m^3/s approx. The m^3/s is a very large rate of flow. In addition such units as m^3/min, m^3/h and m^3/day will be used, as will litre/s, litre/min. and litre/h.

Density – kilogram per cubic metre (kg/m^3) 1 lb/ft^3 = 16.02 kg/m^3 approx. For gas densities, the kg/m^3 will be a useful unit. For solids and liquids, derivatives such as kg/litre, g/ml and g/cm^3 will be employed.

Pressure and Stress pascal (Pa) – 1 lbf/in^2 = 6.9 kPa approx. The bar and millibar are commonly used in many countries, the bar being equal to 10^5Pa. In the British gas industry, the pressure of low pressure gas is normally measured in terms of inches of water. The corresponding metric unit could be millimetres of water for specialised uses such as this.

Energy (work and heat) – joule (J), 1J = 1 Nm 1 Btu = 1055 J approx.

The joule – sometimes expressed as the newton-metre – is the SI unit for all forms of energy. This illustrates the unifying potential of the International System. It has been recommended that the megajoule (MJ) should be adopted as a practical unit for the sale of gas to small consumers.

Heating value – megajoules per cubic metre (MJ/m^3) 1 Btu/ft^3 = 0.03726 MJ/m^3. The international Gas Union has recommended the MJ/m^3 for heating value and for Wobbe index. Typical fuel gases have heating values ranging from 10MJ/m^3 to 40 MJ/m^3.

Power (Watt, (W) – 1 W = 1 J/s = 1Nm/s) 1hp = 746w, approx.
It is likely that the GW, MW kW and W will be applied as the units for large quantities of power, with the mW and sub-multiples applied to small power consumption and output. The combination of the joule as the unit for measuring the heating value of the gas input to a machine and the watt for the power output will lead to simplification in determining efficiency, as compared with the current practice of measuring a Btu or k.cal input and comparing it with hp or metric horsepower output. Generally it can be said that the adoption of units such as the newton, joule and watt in place of the kilogram-force, calorie and metric horsepower, can lead to the simplification of design calculations in industrial processes.

Temperature
$^oC = 5/9 (^oF – 32)$ $K = 5/9 (°F + 459.67)$ $°R = °F + 459.67$

Thermal conductivity (k)
1 Btu in/ft^2h °F = 0.144228 W/m K

Thermal conductance (U)
1 Btu/°F = 5.67826 W/m^2 K

Heat flow rate
1 Btu/h = 0.293071 W

Intensity of heat flow rate
1 Btu/ft2h = 3.15459 W/m^2

Pressure
1 lbf/in^2 = 6.895 kPa (68.9476 mb)
1 in H_2O (water gauge) = 249.089 Pa
1 in Hg (mercury) = 3.38639 kPa

Energy (work, heat)
1 therm = 105.506 MJ
1 Btu = 1.05506 kJ
1 hp.h =2.68452 MJ (Horsepower hour)
1 kWh =3.6 MJ

Thermal capacity per unit
Mass (specific heat)
1 Btu/lb °F = 4186.8 J/kg°C
1 ft lbf/lb °F = 5.38032 J/kg°C

Specific energy
1 Btu/lb = 2326 J/kg

Heating value
1 Btu/ft^3 = 0.03726 MJ/m^3

Density
1 lb/ft^3= 16.0185 kg/m^3

Mass rate of flow
1 lb/h = 0.453592 kg/h

Volume rate of flow
1 ft^3/s (1 cusec)= 0.0283168 m^3/s

Velocity
1 ft/s = 0.3048 m/s

Acceleration
1 ft/s^2 =0.3048 m/s^2

The implications for industry generally and for gas engineering in particular, when the SI units are adopted, are manifold and significant.

A few of the more important are:

Mass (kilogram kg = approx. 2.2 lb): The microgram, milligram (mg) and gram are used when small masses are involved. The kilogram itself is used in trade but for large masses (eg. solid fuel in bulk), the megagram (Mg) is the strict SI unit. In practice the unit used is the metric ton (1 tonne = 10^3 Kg ie. 1000 Kg.

Temperature (Kelvin-K) 1°F =5/9 K: The Fahrenheit scale is incompatible with the SI. The Celsius scale is not strictly SI but as 1°C = 1 K, the degree Celsius will be the customary temperature scale.

Area (Square metre m2) 1 ft = 0.093 m² approx.: The square kilometre (km^2), square metre (m^2), square decimetre (dm^2), square centimetre (cm^2) and square millimetre (mm^2) are the main units employed for area measurement. For land measurement, the area and hectare are used but these are simply related to the square metre. 1 are(a) = 10^2m^2 and 1 hectare (ha) = 10^4m^2.

APPENDIX IV
CONTACT DETAILS AND ACCIDENT REPORTING

All electrical and gas accidents must be reported to the Office of Energy Telephone: 1800 678 198 (all hours)

Office of Energy Technical & Safety Division locations and contact details are as follows:

Office of Energy Perth
20 Southport Street
WEST LEEDERVILLE WA 6007
Tel: 9422 5200
Fax: 9422 5244

Office of Energy Karratha
C/o Department of Minerals & Energy
SGIO Building
Hedland Place
PO Box 518
KARRATHA WA 6714
Tel: 9186 8276
Fax: 9186 8251

Office of Energy Kalgoorlie
c/o Department of Minerals & Energy
48-52 Brookman Street
PO Box 10078
KALGOORLIE WA 6430
Tel: 9021 9418
Fax: 9021 3612

Office of Energy Geraldton
Suite 2, 8 Chapman Road
PO Box 2126
GERALDTON WA 6530
Tel: 9964 5133
Fax: 9964 5149

Office of Energy Collie
c/0 Department of Minerals & Energy
66 Wittenoom Street
PO Box 500
COLLIE WA 6225
Tel: 9734 1222
Fax: 9734 1606

Office of Energy Website – www.energy.wa.gov.au

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